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In an experiment to determine the most efficient design for the commentary of an instructional film, special consideration was given to three variables concerned with the construction of commentaries: the level of verbalization (the amount of talk), the personal reference of the narrator, and the phase relationship between the commentary and the film (sound leading the picture, or sound lagging behind the picture). Naval trainees viewed several different motion pictures, each teaching basic information about knot-tying, but each varying from others on one of the three variables. After the instruction the trainees were tested on the perceptual-motor tasks, namely the tying of three difficult knots. The experiment showed that a moderate amount of verbal description of the task aided learning while too much talk hindered it. Statements using the imperative mood or the second person active were more effective (in this military group) than those using the third person passive. Finally, a "leading" commentary helped trainees more than a "lagging" commentary. (BB)

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TECHNICAL REPORT.- SDC 269-7-4

COMMENTARY VARIATIONS: LEVEL OF VERBALIZATION, PERSONAL REFERENCE, AND PHASE RELATIONS IN INSTRUCTIONAL FILMS ON PERCEPTUAL-MOTOR TASKS

(Rapid Mass Learning)

Pennsylvania State College
Instructional Film Research Program
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FOREWORD

Viewed broadly, it may be said that there are two great areas for research involving the sound motion picture: (1) the complex streams of events which occur in the sequences of pictures, and (2) the equally complex streams of events which occur in the sound track or commentary. Also viewed broadly, two modalities of perception, visual and auditory, challenge study. Furthermore, these two streams of events, as they are channeled through the sensory processes of seeing and hearing, meet and merge in the brain. Here the problems arise of how these varieties of stimuli interact, integrate, reinforce or inhibit the communication of meanings.

This area of research is extremely complex and difficult. The meaningful definition of even a few of the problems and the isolation of some of the variables is no mean achievement. Mr. John Zuckerman, in the research project of which this is a report, has not only defined several important variables, but he has also developed experimental designs which have led to significant new viewpoints which producers of instructional films may wish to consider in the future. As is the case with most research, more questions have been raised than answered. However, many new problems which challenge investigation can now be more precisely defined as a result of this study than was possible before. As always, there is the question as to what extent the findings reported by Mr. Zuckerman can be applied to other kinds of instructional films, designed for other audiences.

We do know these things with some increased degree of confidence: (1) There can be too much talk as well as too little in film commentaries, (2) the pronouns or forms of address make for differences in the instructional effectiveness of a film, and finally, (3) in the production of a sound motion picture intended to give training in skills, serious consideration should be given to the problem of the timing of the verbal directions (or cues) with the visual directions (or cues). It may be suggested that either the visual or sound cues should be given a time priority, depending upon their relative importance at various points in a film for instructing trainees in the performance of the task.

The main problem area of film research, which involves learning more about how the visual and verbal streams of events in sound motion pictures can be integrated and presented for the maximum communicative effect, requires extensive exploration. This study represents a beginning in this direction.

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SUMMARY

Problem

The purpose of this study was to determine the effects of three kinds of variations in the commentary of instructional films, on the learning of knot-tying tasks. Various levels of verbalization of the action and relationships of parts occuring in films demonstrating the tying of the bowline, sheet bend and Spanish bowline, were tested. Two other types of variations were also investigated: the use of different kinds of personal pronouns (personal reference) in the commentary, and the role played by the phase relations of the picture and sound.

The variables were designed as follows:

1. Levels of verbalization: none, low, medium, high.

2. Personal reference: 1st person, 2nd person, 3rd person passive, and imperative.

3. Phase relationships: sound leading the picture, sound lagging behind the picture.

Procedure

Specially produced experimental motion pictures demonstrating the tying of the three knots (bowline, sheet bend and Spanish bowline) were shown to groups of Naval trainees. The 1787 men were divided into groups of about 60, and comparisons were effected through pairs of these experimental groups. The test of learning was the actual performance of the knot-tying tasks immediately after a film-showing of each knot. After a literal time allowance for the tying, the correctly tied knots were counted.

Results

Level of verbalization. 1. No Sound. In terms of the proportion of subjects tying the knots correctly, this film was the weakest of all the experimental versions.

2. Low Level Verbalization. The addition of descriptions of the main movements used in tying the knots increased the number of correctly tied bowlines and Spanish bowlines, while it had no significant[1] effect on the number of sheet bends. This may be explained by the fact that tying the sheet bend requires some intricate orientation of the tying lines, which was not brought out at this level of commentary. 3. Medium Level Verbalization. This film was the best of the verbalization series, in terms of the numbers of subjects tying all three knots correctly. This version was produced by the addition of cues of orientation to the commentary in the Low Verbalization film, which gave information about the crossing of lines to right or left, formation of loops above or below lines, etc. 4. High Level Verbalization. The addition of detailed descriptions of the appearance of parts, in this film, not only did not improve performance, but caused a distinct drop in the proportion of correctly tied knots. Learning from the film was almost identical with that from the Low Verbalization version, but was better than that for No Sound.

Personal Reference. 1. 1st person ("I"). This version, according to the proportion of knots correctly tied, was third in the order of the films in this section of the experiment, but it did not differ significantly from the others. 2. 2nd person ("You"). This version was equal in effectiveness to the film using the imperative mood, and these two were the best in the series in terms of the proportion of subjects tying the knots. 3. 3rd person passive ("A loop is formed..."). This was the least effective film in the group, differing from the film using the imperative mood and 2nd person in that a significantly lower number of subjects tied the knots correctly. 4. Imperative mood ("Form a loop..."). The film which used imperative mood was equal in effectiveness to that which used 2nd person, and both these films were on a par as the most effective in the series.

Phase Relationships. The overall results from using the two films in this group demonstrated that the film with sound leading the picture, that is, where the commentary

[1] The word "significant" is used here in the statistical sense, where the probability of obtained differences being due to chance, is 5 in 100 or less.

slightly precedes the visual representation it describes, was superior to the film in which the commentary follows slightly behind the visual representation on the screen. When the analysis for each individual knot was made, however, it was found that results for the Spanish bowline presented the only statistically significant difference. This may be explained by the varying levels of difficulty of the three knots. There were more cues in the Spanish bowline commentary than in those for the other two knots, as the sequence of knot-tying movements was relatively more complex.

Conclusions

The exploratory nature of the experiment places restrictions on its interpretation, as do the nature of the task and the brevity of the experimental films. Even with these limitations, the following conclusions seem justified:

1. In teaching knot-tying tasks by means of instructional films, some verbal descriptions of the acts assist the learner, but verbalisation may be increased to a point where it interferes with, and actually reduces, learning.

2. With a military population in an authoritarian atmosphere (the situation encountered in the present experiment) directive statements using the imperative mood, or the 2nd person active are more effective than 1st or 3rd person in promoting learning. Third person passive statements which are commonly used in film commentaries are least effective.

3. The phase relationships of the auditory and visual elements in sound films teaching knot-tying had an important bearing on the effectiveness of the films. It is possible that this timing variable is closely related to the level of difficulty and complexity of the task. Further research is needed to ascertain the procedures for determining the optimal phase relations of picture and commentary in sound films.

Recommendations

Tentatively, one might offer the following suggestions for film writers, directors and film project officers based

upon the above conclusions:

1. There is an optimal level of verbalization in the commentary; care should be taken not to load the sound track with too much verbal detail, nor, on the other hand, should verbal descriptions of crucial visual relationships be omitted.

2. For military trainees accustomed to direct orders, strong directive statements may be more desirable for promoting learning than passive statements. There is some evidence that the personalization of commentary by use of the 2nd person ("you") is helpful.

3. Where the learner must be alerted to a visual relationship or detail, some advance direction in terms of seconds of commentary lead is desirable.

Commentary Variations: Level of Verbalization, Personal Reference and Phase Relations in Instructional Films on Perceptual-Motor Tasks

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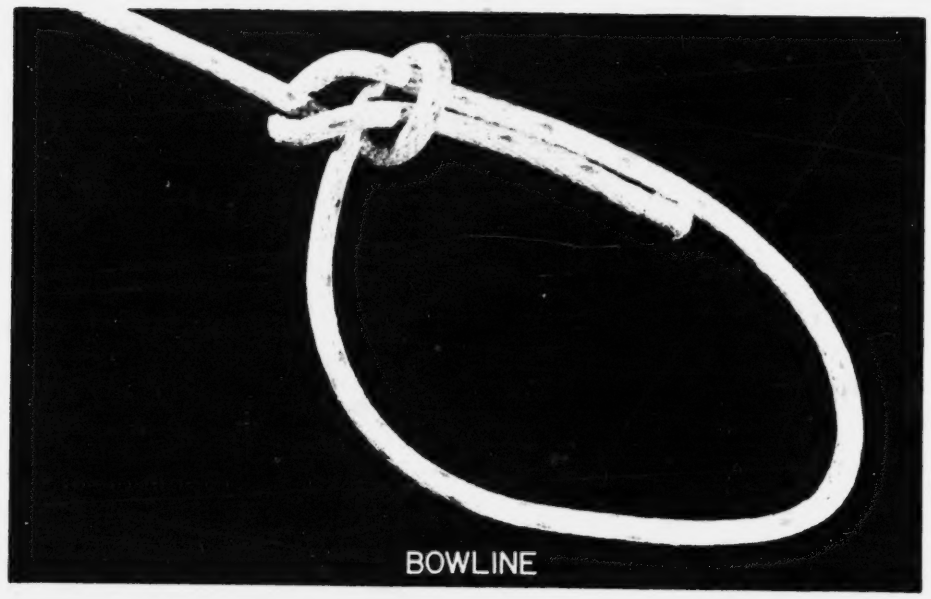
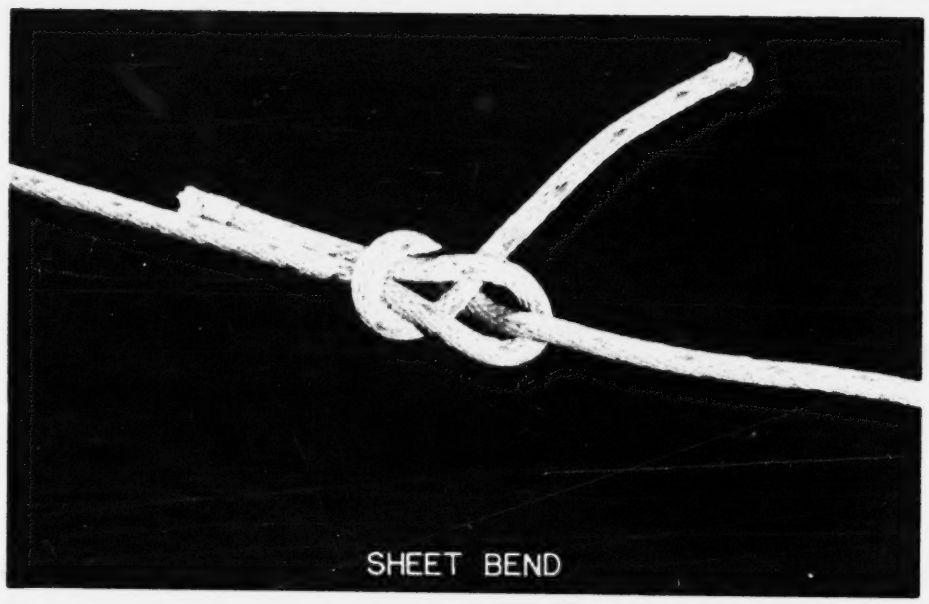
STATEMENT OF THE PROBLEM

Introduction

The inter-relationships of the dynamic variables which make up the sound motion picture are exceedingly complex. When one considers the number of dimensional characteristics which the film may possess, it is difficult to make even a beginning at the analysis of motion pictures into basic elements, and to investigate the effects of those elements on learning. Even when such a preliminary analysis is made, it seems that the contributions of sound and picture to instruction vary greatly with the subject matter of the films, the presentation methods, and the audience. Further, because of the difficulty of isolating auditory and visual elements, little has been done to obtain scientifically derived knowledge of their individual effects. This study is an attempt to deal experimentally with some dimensional variations of the spoken commentary which is associated with motion pictures demonstrating knot-tying tasks.

In approaching the problem of the effect of the aural variables in sound motion pictures, the author was confronted with almost a complete absence of experimental reports in the available literature concerning specific aspects of commentary. There were references to the differences in learning from silent films, from films with professional narration in the soundtrack, and from films with narration read by non-professionals (usually teachers) (6), but no experimenter had gone further into the analysis of variables which operate under the general label of "sound track". Because of the lack of research tradition, the approach to the investigation was made on the simplest possible level, in order to establish, if possible, some criteria for defining sound track variables, and to make a first attempt to measure their effects.





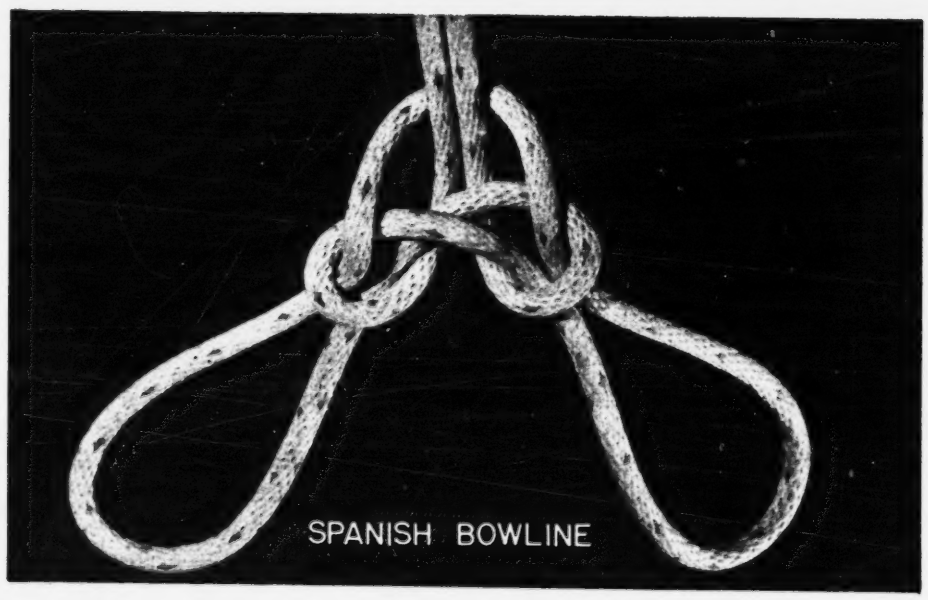


FIGURE 1. Knots used in the experiment

While the preliminary investigations were being carried on, an opportunity was provided for examining, rather closely, a group of experimental motion pictures dealing with the tying of three common knots (bowline, sheet bend and Spanish bowline, see Figure 1, page 6), which had been produced for another project of The Instructional Film Research Program (15). Since knot-tying is clearly a perceptual-motor task, the visual material in these films was very suitable for investigating the extent to which verbal material of various kinds would add to the success of learners in tying the knots. This task also made possible isolation of the effects of commentary in a way not possible in most kinds of conceptual learning situations. In addition, since learners could be asked to perform the knot-tying tasks, the test of learning itself could be freed from the effects of verbal symbols, and was therefore of unquestionable validity. The use of such a simple task eliminated from consideration such dimensions as emotionality of language and motivational problems, and enabled the level of verbal difficulty of the commentary to be held at a minimum. These were factors which conditioned the choice of the visual material used in the experiment. The sound track variables to be tested were defined after a series of conferences with experienced members of the Instructional Film Research Program.

History

Among the sources of information about instructional motion pictures which seem worth summarizing, the following investigations, concerning the presence or absence of a sound track, or modes of presentation such as sound track versus a teacher's commentary, are representative: Einbecker (4), Mead (12), McClusky, F. D. (10) and Westfall (16). All these investigators found that, as Hoban summarizes: "Oral commentary on a film is more effective than presentation of a film without oral commentary or with written titles." (Hoban (6), page 354) Einbecker (4) found also that the teacher was more effective in teaching technical words with a silent film than was the sound film alone. Clark (3) determined that silent and sound films were equal when results were measured in terms of factual information. Generally speaking, the results of all the studies indicate that some verbal accompaniment to a film is necessary when the learning is to be measured by verbal tests. The relative superiority of the sound film or the silent film with a teacher's commentary, depends on the subject matter and the type of commentary.

Lockhart (9) experimented with the use of motion pictures as an aid to other forms of instruction in the teaching of a motor skill (bowling), and found that the films improved bowling scores when used during the middle portions of an instructional course.

Park (13) found that "Long sentences in commentary resulted in decrease of comprehension". He also pointed out that technical or difficult words could not be taught in one film showing (14).

"In practically all studies,... the measurement has been in terms of verbal responses of pupils on objective tests of factual information. The data from these investigations, consequently, are applicable only to those types of learning which were measured on the verbal level by these tests. Such outcomes as vividness of imagery, variety of visual detail and so on, were ignored by the experimenters" (Hoban 6, page 353).

Such items as sense modality variations in learning, types of oral presentation (dramatic, narrative, etc.), emotional toning of language and delivery, speaker of recognized authority versus professional narrator, etc., have been considered during research planning on the Instructional Film Research Program, but they have not been dealt with in published experimental studies. Pioneer work in this area is now being done on the Instructional Film Research Program. A study by Jaspen (7) on the learning of the assembly of the breech block of the 40 mm antiaircraft gun indicated that verbalization at a medium level might be more effective in promoting learning than either higher or lower amounts of verbalization, as measured by words per minute in the commentary.

Definitions and Hypotheses

Since there existed no theory and supporting experimentation on commentary dimensions, it was necessary to define commentary variables and select those which might be fruitful to study. It was assumed that, although the knot-tying task was chiefly a perceptual one, there would be a sufficiently large variation in the use which could be made of verbal cues, so that some kinds of commentaries would be more effective than others.

The group of motion pictures demonstrating knot-tying had been produced for testing, among other concepts, the

hypothesis that an accurate representation of a learner actually performing a task would be more likely to promote learning than a less realistic representation, such as the presentation of sequences in knot-tying without the use of movement, or without the showing of the performer's hands in the picture, (15). Preliminary experimentation with two of the series, a film photographed from the performer's own viewing point, and one showing what one sees as another is demonstrating the task (so-called "subjective" versus "objective" camera position) raised the question as to the value of some kind of subjective versus objective commentary which could be associated with the film versions. While observing subjects during preliminary testing of the films just described, it was also noted that the directional cues as to what movements to make, could come from either the picture or the commentary. Apparently the time relationship of picture to voice was also of critical importance in determining what cues subjects used in copying the patterns of actions.

Re-examination of the knot-tying films produced a set of commentary dimensions which were capable of internal variation in degree. They were identified and assigned criterion measurements as follows:

1. Level of verbalization. The amount of verbal description which can be included with any motion picture is limited physically by the running time of the film. In considering the knot-tying films, the concept of level of verbalization seemed related not only to the number of words used, but also to the kinds of words. The films demonstrated the tying of the three knots (bowline, sheet bend, Spanish bowline) in a series of discrete stages, each made up of a movement and a positional relationship. The movements were describable by transitive verbs with their objects. This type of description was designated as the low level of verbalization. The next degree of description which seemed possible was the addition of orientation terms to describe the method of approaching one part with another, or the relationship of the parts to one another in a static state. This was termed the medium level of verbalization. Finally the high level of verbalization included, in addition, a detailed description of the appearance of the specific parts of the knots at every stage of tying. In addition to these three levels, a silent film was used as a base from which to measure sound track contributions. The criteria for levels of verbalization can be stated numerically to provide precise definition of the dimension. (See Table 1, page 10)

TABLE 1

CRITERIA FOR COMMENTARY VERBALIZATION

Knot	Criterion Measure	Number of Occurrences Low	Medium	High
BOWLINE				
	Action statements . . .	9	9	9
	Orientation cues . . .	0	7	7
	Details of appearance .	0	0	6
	Total number of words used*.	66	92	120
SHEET BEND				
	Action statements . . .	8	8	8
	Orientation cues . . .	0	7	7
	Details of appearance .	0	0	6
	Total number of words used*	62	89	134
SPANISH BOWLINE				
	Action statements . . .	11	11	11
	Orientation cues . . .	0	14	14
	Details of appearance .	0	0	10
	Total number of words used*	80	125	176

* The verbal density expressed in words per minute of film is as follows:

	Low	Medium	High	Film Length
BOWLINE	102	141	185	39 seconds
SHEET BEND	98	141	211	38 seconds
SPANISH BOWLINE	71	111	155	68 seconds

2. Personal reference. In investigating the subjective-objective camera positions (15), it was determined experimentally that the film version which was by far the more effective was the subjective one (photographed from the performer's point of viewing). The question of what kind of commentary would best fit the "good" picture and aid learning was a puzzling one. If the extensive use of the 2nd person ("you"), in various kinds of advertising materials designed to incite individuals to action were any guide, that type of commentary should be most successful in promoting learning. Also, public speaking authorities advocate this kind of reference (Borden, 2). The 1st person was used in one version, in order to take advantage of whatever significant element of subjectivity there might be in the use of the pronoun "I" in an otherwise objectively oriented commentary. The imperative mood was also used in one of the variations to include the type of personal reference most closely related to a military situation, in which the tests were to be made. A review of the commentaries of a number of motion pictures dealing with instruction in various subjects revealed a marked preference for "elegant" construction using the 3rd person passive ("a loop is formed"...). It was suspected on a priori grounds that there was very little justification for this kind of commentary, and it was included to check this hypothesis (see Flesch, 5). In Table 2 (page 12), a count of the number of times the 1st and 2nd person pronouns appeared in the commentary is given.

3. Phase relationships. The perceptual-motor task of knot-tying is well adapted for testing the phase relations or timing of sound to picture, since it consists of a series of relatively discrete stages of movements, with distinct pauses between them. However, the shortness of the films which were available and the small number of stages in two of the three knots rather restricted the scope of the phase relationship study. There were three obvious time relationships of commentary to picture: (1) commentary leading the visual image on the screen, (2) commentary lagging behind the visual image on the screen, and (3) commentary in synchronism with the visual image on the screen. Preliminary tests suggested that, with these films, differences among the three degrees of phase relationship would be too small to be significant. Therefore, as a preliminary step in the study of phase relationship, investigation of this variable was limited to a study of the two extremes (lead and lag) to determine whether the variable had any effect on learning.

TABLE 2

COUNT OF 1ST AND 2ND PERSONAL PRONOUNS
IN KNOT-TYING COMMENTARY*

Knot	Number of Occurrences	
	1st Person	2nd Person
BOWLINE	6	6
SHEET BEND	8	8
SPANISH BOWLINE	12	12

* The commentary with the medium level of verbalization with personal pronouns added was used for studying this variable.

The lead version provided that the commentary begin a description of a motion approximately two seconds before the corresponding picture began to appear on the screen; the lag version provided that the descriptive commentary should commence three seconds after the corresponding motion began to appear on the screen.

After the dimensions for the experiment were defined, the problem of their inter-relationship was considered. It is recognized fully that considerable interaction must exist between the amount or level of commentary verbalization and the action on the screen. In addition, it is certainly true that the number of sentences in the commentary restricts the number of personal references which can be used, and therefore restricts the effect of the personal-reference variable. Unfortunately the testing of second-order effects in motion pictures of such brief over-all duration seemed impractical in view of the complexity of the factorial design required for this kind of experimentation (instead of 7 motion pictures, 32 would have been needed). It was therefore assumed for the purposes of this study that the three variables to be tested were relatively independent in nature. Such an assumption can be defended on an apriori basis; in any event, it would not invalidate the experimental results. Of the many possible sound track variables, those that have been defined here, are undoubtedly among the simplest. It must be stressed that, when the basic experimental work in this area has been supported by a number of other studies, work on interaction must be furthered because of its importance.

PROCEDURE

The Task and the Films

The task. The selection of a criterion measure in film research which has an unequivocal relationship to the variable under examination is difficult; sometimes it is impossible. Previous investigations of motion picture variables have almost all used paper-and-pencil tests; this procedure is appropriate to some degree when general learning of a conceptual nature is being measured. But when the experimental variable is a few seconds' difference in the timing of the sound track and the visual material which it accompanies, or when the difference is between "I" and "you" in the commentary, it is difficult to envisage clearcut differences being obtained by written tests. Therefore, the existence of films especially designed and produced for testing by performance was fortunate for this study. The advantage of a performance test outweighed the problems created by the necessity for testing large numbers of trainees. Because of the admittedly exploratory nature of this study, it was not considered objectionable that the effects of variations in commentary on knot-tying might not be generalizable to other motor skills, or to other kinds of learning, without further testing.

The motion pictures. A set of three motion pictures, each showing one knot-tying task, was chosen from the group made for Dr. Roshal's study discussed above in the section on Definitions and Hypotheses. The films which were used for this experiment were photographed in black-and-white, and they showed the hands and arms of a Naval trainee tying the knots. The camera presented an "over-the-shoulder" view of the knot-tyer's hands (subjective or "0°" camera angle). The films were of the following lengths: bowline 39 seconds, sheet bend 38 seconds, and Spanish bowline 68 seconds. The individual knot-tying representations were separated by titles, both printed and oral, which were identical for each knot, as follows:

> "This film will show you how to tie a knot. After the film, you will be asked to tie it."

In addition, printed titles which identified the knot to be tied preceded each film (TYING THE BOWLINE, etc.).

The experimental variations involved the preparation of seven commentary scripts in accordance with the variables which have been defined in the previous section. Each of the seven tracks was spoken by a professional commentator, and each was printed in combination with the basic motion picture. The narrator worked from chronometer timed cues, so that the rate of delivery and relationship of sound to visual elements were held constant. There was controlled emotional toning of the language of the scripts, and the voice inflections were held as constant as possible by the commentator. An eighth experimental version used as a control film was obtained by projecting one of the prints of the film silently (necessary minimum instructions were contained in the film titles). Table 3, page 16, lists the film versions with their variables. The complete scripts are presented in appendix A.

Test Materials

Group testing was made possible by the use of specially prepared test sets. Six-foot lengths of No. 7 sashcord were prepared and treated at the ends with transparent cement to prevent ravelling. The lines were inserted in 10"x13" manila envelopes, which were stamped with the names of the knots to be tied. (One piece of line, each, sufficed for the bowline and Spanish bowline, while two pieces of line were necessary for the sheet bend.) Identification tickets (small white paper slips temporarily cemented to the corner of each envelope) provided a means for recording the names, service numbers and group identification of the subjects. To facilitate the scoring of the completed knots, a set of photographs was prepared of the correct knots (as taught by the motion picture) and of certain common variants. The photographs were later used by the scorers to compare with the knots obtained.

Test Population

Arrangements were made with the Bureau of Naval Personnel on behalf of the Instructional Film Research Program to use Naval trainees as subjects for appropriate kinds of motion picture film experimentation.

TABLE 3

EXPERIMENTAL FILM VARIATIONS*

Film Number	Level of Verbalization	Personal Reference	Phase Relationships
I	No sound	No sound	No sound
II	Low	Imperative	Sound leading
III	Low	Imperative	Sound lagging
IV	Medium	Imperative	Sound leading
V	High	Imperative	Sound leading
VI	Medium	1st person	Sound leading
VII	Medium	2nd person	Sound leading
VIII	Medium	3rd person passive	Sound leading

* Variables were defined as follows:

		Film
Level of verbalization:		
None:	Film shown without sound.	I
Low:	Gross actions described by transitive verbs and objects.	II
Medium:	Addition of orientation cues, "left", "right", "rear", etc.	IV
High:	Addition of detailed description of appearance of parts, as "three inch loop."	V
Personal reference:		
Imperative:	Directive statements.	IV
1st person:	Appropriate pronouns added to Imperative.	VI
2nd person:	Appropriate pronouns added to Imperative.	VII
3rd person:	Statements changed to passive voice, and "it" inserted where appropriate.	VIII
Phase relationships:		
Sound leading:	Verbal statements begun 2 seconds before start of corresponding visual movement.	II
Sound lagging:	Verbal statements begun 3 seconds after start of corresponding visual movement.	III

Since this task was particularly appropriate, it was found desirable to use Seaman Recruits at the Great Lakes Naval Training Center, Great Lakes, Illinois.

The Commanding Officer of the Recruit Training Command, Great Lakes NTC, provided the experimenters with authority for conducting the research, and the Scheduling Officer arranged the testing periods to meet the needs of the experimental design. During the time of testing, from 12 January to 8 February, 1949, the unit for Seaman Recruits at the Center was a 60-man company. Classrooms which were available could hold double that number of men in the testing situation used, so that two 60-man groups (which normally worked and lived together) were scheduled for each test session. All together a total of 1787 naval trainees took part in the experiment.

Sampling. The experimental design required the showing of experimental films simultaneously to two groups of subjects split at random from the larger population unit of two companies. Since each Recruit Company was formed into a column for marching on the basis of height, adequate randomness was secured by the assignment of men alternately from the marching group to each of two classrooms. Randomization by roster would have been impracticable because of time limitations imposed by a fifty-minute testing period, and because of the fact that a few of the subjects were not present at test sessions because of other duties or illness.

The relationship of the test population to the general universe of Naval trainees was not controlled. The companies did represent all men arriving at the Center for recruit training during the period of the experiment, and recruits were ordinarily assigned to companies in accordance with the date of their arrival. It is known that recruits inducted just after the high school graduation times of January and June are apt to have more years of education and perform better on Navy tests than those recruited in mid-winter. Fortunately, performance scores on two Navy tests were available for most of the subjects, and later analyses of these demonstrated with some degree of confidence that the subjects could be assumed to be a homogeneous group. (See Tables 11 and 12 and the discussion in Appendix D.)

Performance comparability. The training schedules for recruits at Great Lakes ordinarily provided knot-tying instruction during the first week of training, but the schedule was modified so that the entire experiment was carried out on recruits without previous knot-tying instruction at the Center. (To avoid the effects of informal instruction by recruit company leaders, they were questioned as to what instruction had been given their men; one group of 120 subjects was discarded, and their test was re-run on another group because their company commander had begun "barracks" knot-tying instruction before the experiment.) No control groups were part of the experiment proper, but a control test run just before the experiment began demonstrated that pre-instruction knot-tying ability was very limited; only seven per cent of the 112 subjects tested were able to tie the bowline, three per cent the sheet bend, and none were able to tie the Spanish bowline (see Table 10, Appendix C.).

Motivation. The subjects were tested in a fairly formal situation, usually in the presence of their company commanders (Chief Petty Officers) who came with them to the tests. The experimenters, though civilians, were accepted generally as leaders. However, since the experimental situation was a novel one to most of the trainees, they explored the limits of freedom of the period. There were no indications of lethargy, and the test period was occupied by instructions and test procedure, so that it may be safely stated that the subjects were well motivated, and that the results were not contaminated by poor attention. Many of the subjects were observed to go through the motions of tying the knots as the demonstrator in the film performed them.

Experimental Design

Origin of the design. The experimental design for the study was patterned after one developed by Roshal for his "learner representation" project in the Instructional Film Research Program (15). It was planned to maintain comparability between the portion of his experiment which involved camera angle changes, and the portion of this study which was concerned with personal reference, so that the two studies might serve as an extension of knowledge about

visual and auditory learner relationships in film materials. The so-called "random-half control" method used in the design was planned by Roshal.

Types of comparisons. It will be remembered that the three dimensions defined for testing were regarded as being relatively independent of each other. Therefore all comparisons were confined within each single variable. The experimental films, for the sake of economy, however, were arranged so that only eight different films were needed to produce ten different points on the testing continua. Study of Table 3 will make this point clear. The choice of medium level of verbalization as the standard for comparing personal references, of low level of verbalization as the standard for comparing phase relationships, and of sound leading as the standard for comparing levels of verbalization and personal references, stemmed from judgements as to which would be the most effective kind of base for these variables.

The data on knot-tying were gathered in terms of correct and incorrect knots tied, and comparisons were made through the differences in proportions and the differences in mean overall scores. Two kinds of comparisons were provided for, one of which was termed the "random-half control" method, and the other a "grouped-data" method.

Random-half control method. This method makes use of all the possible relevant comparisons for each film version. First, there is a direct comparison using the random halves of a group of 120 men for each film-pairing. By using another relevant version as a common base, indirect comparisons are made available. For example, versions I and II were prepared and presented to random halves of one group. The same was done for film pairs I and IV, and II and IV. By pivoting on version I, an indirect comparison of II and IV can be made:

$$(II-I) - (IV-I') = (II-IV)$$

While I is not necessarily equal to I', it is assumed that, except for random sampling errors, an estimate of which enters the standard error formulation, any difference between I and I' reflects systematic differences in the populations which are thus controlled.

It is further assumed that these systematic differences are additive and that for present purposes the difference of 10 per cent in correctly tied knots between 50 per cent and 60 per cent is equal to the 10 per cent difference between, say, 5 per cent and 15 per cent.

The main value of the random-half analysis lies in the adjustments which were automatically made for inter-company differences in initial knot-tying performance, or other relevant variables, since each comparison was made within a given experimental group of 120 men (really two companies of 60 men each). Since the groups were each divided into random halves, and intra-company differences thus randomized, variations in scores between the two halves on performance could be attributed to the variations in the experimental material. This compensated for any systematic differences between companies from the beginning to end of the experiment.

The companies were assigned to the experimental versions in accordance with a table of random numbers, within each of the three sections of the experiment. The sections were designated arbitrarily for first, second and third place in the experimental period. Two experimenters were needed to handle the paired tests, and the effect of the personal variable was minimized by assigning each experimenter to an equal number of administrations, for each film version tested.

Grouped-data method. In this method, the scores for all the randomized half-companies viewing a particular film version were grouped. Comparisons were then made among the summed scores for the pertinent film versions. This grouping is based on the assumption that the probability of biasing the sample in favor of any given version is very low, where randomly selected half-companies are used.

Test Administration

The tests were administered by two experimenters, each testing half of the subjects in a group. The marching columns of each two companies were divided at

classroom doors as explained above under Subjects-Sampling. The men were seated in alternate seats, each next to a seat which had been pre-set with test material in the form of three envelopes containing lengths of line. After the subjects were seated, they were given time to remove their jackets and then the purpose of the experiment was explained to them (See Instructions to Subjects, Appendix B). After the men had printed personal data on the identification tickets, the experimental films were shown, one knot at a time. After each knot-tying picture, the men were asked to tie the knot. Time allowances, determined by pre-test, were: bowline 1¼ minutes, sheet bend and Spanish bowline, 2 minutes each. After the knot-tying was completed, some of the experimental groups were given a brief pencil-and-paper test as a portion of another project.[1] Proctors assisted the experimenters in setting out and collecting test materials, and gave detailed instructions to subjects when necessary.

During the administration of the experiment, the motion picture projection was handled by regular Naval projectionists. However, the projectors at the Training Center were not uniform in performance, and it was necessary to discard five experimental groups numbering about 600 subjects, and re-run those sections of the experiment in which they were involved.

Proctors and Test Scoring

Proctors. The Naval Training Center's Recruit Training Command supplied the experimenters with a number of Seaman Recruits each week to serve as assistants during the experiment. It was the original plan to obtain these men from among those scoring more than one sigma above the mean on Navy classification

[1] A study of "learner characteristics" is being made by Dr. A. W. VanderMeer, of the Instructional Film Research Program. He is seeking to determine whether there are differences in learning from various kinds of film material, among individuals performing differently on certain criterion tests. His results will be published in the future as a separate report.

tests; however, there were no opportunities to select such men, and those used were probably a random sample of trainees at the Center. The men who were assigned to proctoring had all served as subjects during the earlier study using the same task (15). They were in their fifth week of a twelve-week training program, termed "service-week", during which they were ordinarily given "housekeeping" tasks of a physical nature to perform. The ten men supplied to the experimenters each week were usually aware that they could be considered privileged, and most of them were reliable responsible workers, able to understand their function in the study being conducted. Although they had served as subjects previously, the proctors were indoctrinated before each week of experimentation, by being put through the knot-tying procedure again. They were also given the paper-and-pencil test used for the "learner-characteristics" study in order that they might instruct subjects later. A two-hour session was devoted to instruction in knot-scoring.

Scoring the knots. The proctors were taught to recognize the correct knots from enlarged photographic representations. They were divided into teams of three or four, each team scoring one of the three knots, and they usually completed the scoring of a test group of 120 within an hour after the test had been administered. In the scoring procedure, letter symbols were assigned to the correct knots, to several common variants, to incorrect knots other than lettered variations, and to no knot. This type of scoring procedure was used to retain all possible information, although the final analysis used only the pass-fail information.

RESULTS

Introduction

The experimental data were grouped according to the various films to which they pertained, and a preliminary examination was made to determine that the scoring method used was adequate to demonstrate any differences which might occur. The data were treated to secure information in terms of proportions of subjects tying knots correctly. Two methods of analysis, the random-half control procedure and the grouped-data method, were applied. The results were comparable, within certain limits due to the differences between the methods. Table 9 in Appendix C contains comparative results from the two methods. In the discussion of the quantitative results, the information from the grouped-data method of analysis has been used since this method lent itself more easily to general interpretation in terms of differences among film versions, and differences for each separate knot.

Quantitative Results

The proportions of subjects tying the knots correctly for each of the film versions used in the study are shown in Table 4, Appendix C. In order to secure overall measures of the effectiveness of the various films using the information available for all three knots, score values of "one" for success and "zero" for anything else were assigned, and mean scores were derived for each film version (See Table 5 Appendix C.). Appropriate statistical procedures were applied to the differences in proportions and to the differences in mean scores to determine the amount of confidence which could be placed in the results. Appendix D details these techniques. The reference datum for discussing the results is the table of differences in mean scores from version to version within each dimension of commentary variation (Table 6). When individual knots are mentioned, the information is derived from the grouped-data analysis of differences among film versions compiled in Table 7.

Level of verbalization. Figure 2, page 25, shows the proportions of subjects tying the knots correctly for each of the films in this section of the study. Before proceeding to evaluate the individual differences among versions, the chi square test was applied to the data from the group of four films to determine whether differences as great as those found might arise by chance (Table 8). The test showed that this was not likely, so that the individual differences were evaluated.

(a) No sound. This film produced the lowest mean score for the four versions (I, II, IV, V) used in this section of the study.

(b) Low level verbalization. The addition of the lowest amount of verbal material had a significant effect on the number of additional bowlines and Spanish bowlines which were tied, but the number of sheet bends diminished. This may be explained by the fact that the tying of the sheet bend depends upon an intricate bit of orientation of two lines which was not explained in this level of commentary (see Figure 1, page 6).

(c) Medium level verbalization. This version was productive of more knots tied correctly than any other in the experiment, in terms of mean scores. It was significantly better than any of the other three versions in the section. Its superiority to both low and high levels is important to note.

(d) High level verbalization. The addition of details of appearance to the medium level of verbalization caused a drop in the proportions of subjects tying each knot. However this version was almost equal to the low verbalization film and was considerably better than the no sound film. It is possible that the drop in scores was due to the high number of words used in the comparatively brief time available; the tabulation of words per minute for the three levels of verbalization shown in Table 1, page 10, makes this clear. The speeds for the bowline and sheet bend commentaries are higher than that for the Spanish bowline, and are beyond what is thought to be the optimum speed for the comprehension of verbal factual material. This fact may have important implications for the writers of film commentaries.

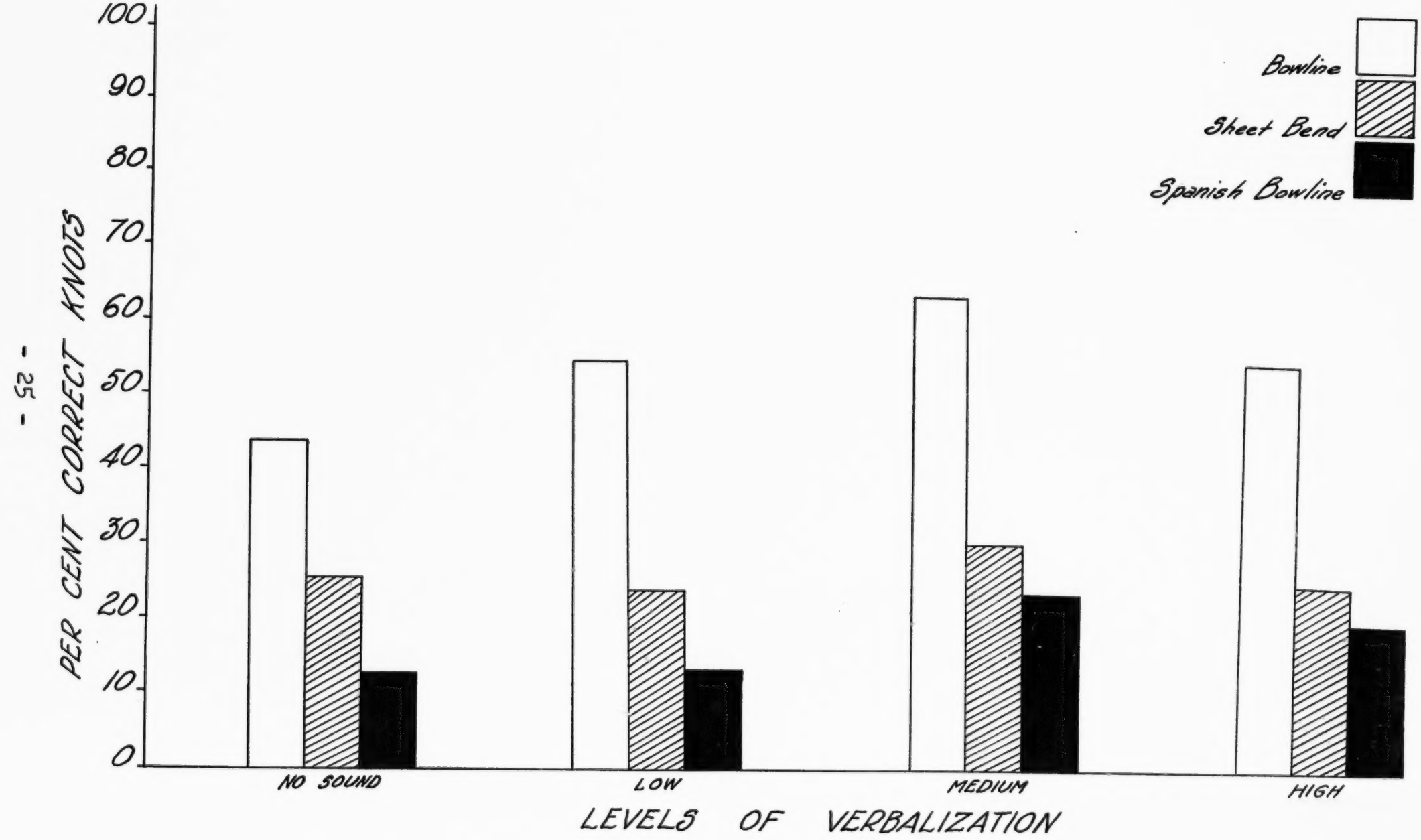


FIGURE 2. Knot tying performance (a) Levels of verbalization section of study

Again the problem of the interaction of amount of verbalization, versus kind of verbalization, versus speed, has arisen.

Personal reference. The proportions of subjects tying correct knots in this part of the study are shown in Figure 3, page 27. This section of the work was subject to some erroneous scoring by the proctors who scored the bowline. Reference to the graphs will reveal some discrepancy between bowline scores and those for other knots. When the chi square technique was applied to this group of films, there was no significant difference reached. However, when the same test was applied to the data with the bowline scores removed, significant differences were shown (Table 8, Appendix C.). It was thought justifiable to examine the data without the bowline scores.

(a) Imperative version. This film was one of the two best in this section of the experiment in terms of the proportions of subjects tying all knots. It was almost identical in effectiveness with the 2nd person version.

(b) 2nd person version. This version had substantially the same content as the imperative film, but with the second person ("you") expressed instead of implied. This film was about equal in effectiveness to the imperative version.

(c) 1st person version. While the results of the film using the first person did not differ significantly in proportions of subjects tying the knots from those of any of the other three films in the series, it was third in order in the hierarchy.

(d) 3rd person passive version. This version was the least effective of the group. It was significantly lower in passing scores than both imperative and 2nd person. The film differed from the other three in using the passive voice throughout the commentary.

Phase relationships. The graph in Figure 4, page 29, shows that the "Sound leading" version (II) was productive of a higher total of correctly tied knots than the "Sound lagging" film (version III). Chi square tests confirmed this statistically, but when the differences for the individual knots were

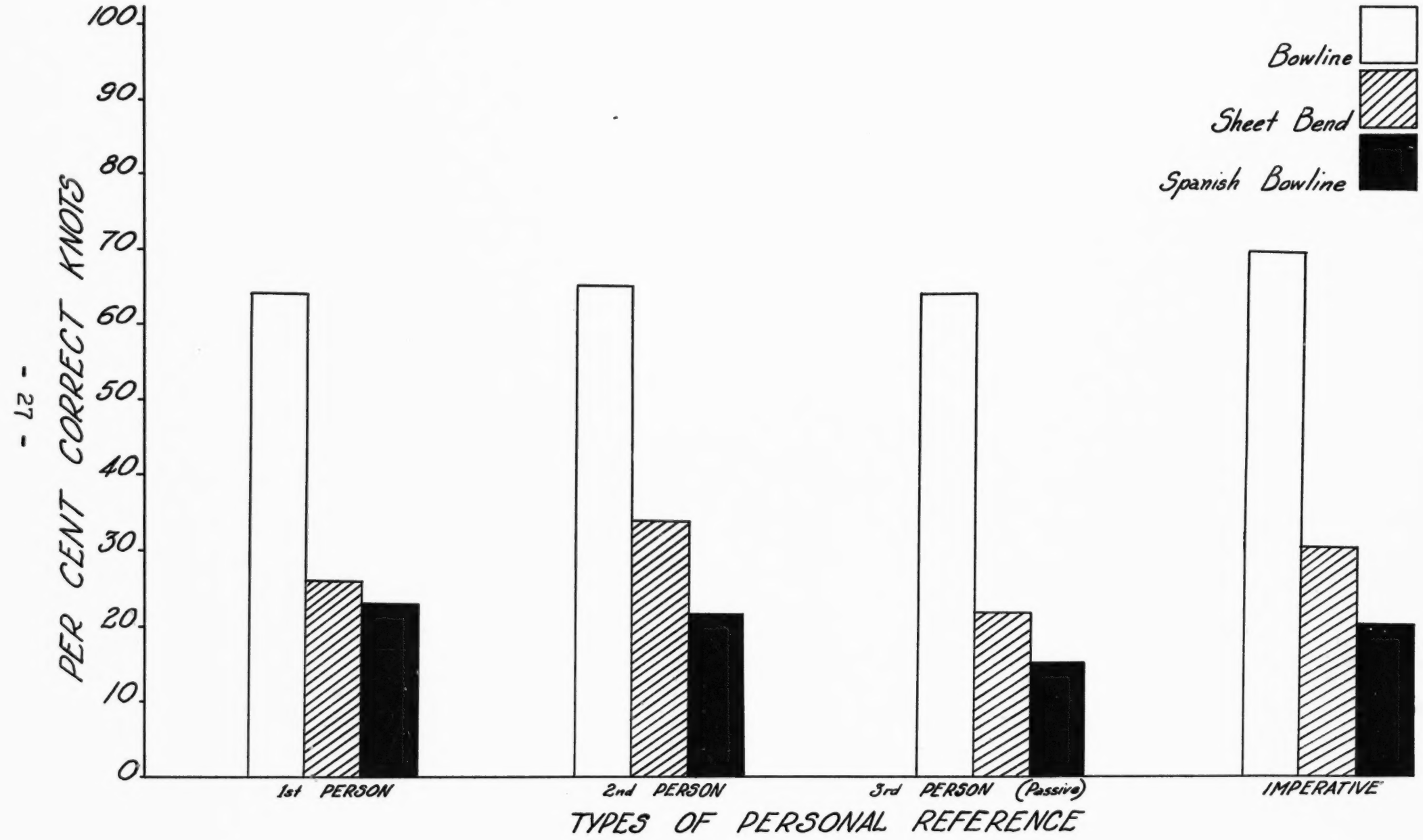


FIGURE 3. Knot tying performance (b) Personal reference section of study

examined, the Spanish bowline was found to be the only one of statistical significance. This may be accounted for by the varying levels of difficulty of the three knots; since there were substantially more stages in the Spanish bowline performance, there were more cues which a "leading" commentary could give to the knot-tyers.

Other Observations

In addition to the main quantitative information discussed above, the study brought out some other information which was of general interest. For example: (1) What is the knot-tying ability of the average Naval trainee before formal instruction in this skill? (2) What is the relationship of levels of difficulty of the knot-tying tasks to the effect of the commentary on performance? (3) What is the relationship of Naval classification test scores to knot-tying performance?

Pre-training knot-tying performances. While the experiment was being set up, informal surveys were made of the subjects' previous knot-tying ability. These showed that about 8 per cent of the subjects questioned claimed familarity with the bowline, about 5 per cent with the sheet bend, and about 1 per cent with the Spanish bowline. A control test on 112 subjects performed just before the main experiment was begun, using the same split-group technique, demonstrated that these figures were approximately correct, the actual figures being 7 per cent, 3 per cent and zero respectively. (See Table 10, Appendix C.)

Level of difficulty of the knots. The knots which were chosen for this task were assumed a priori to be of different degrees of difficulty. While the experiment was not performed to test this point quantitatively it can be seen easily from an examination of the results (Table 4, Appendix C) that the levels of difficulty were quite distinct. Pre-tests resulted in the arrangement of the films for each test in order of difficulty for the testing, on the theory that tasks arranged in order of increasing difficulty are less frustrating, and that the results would be

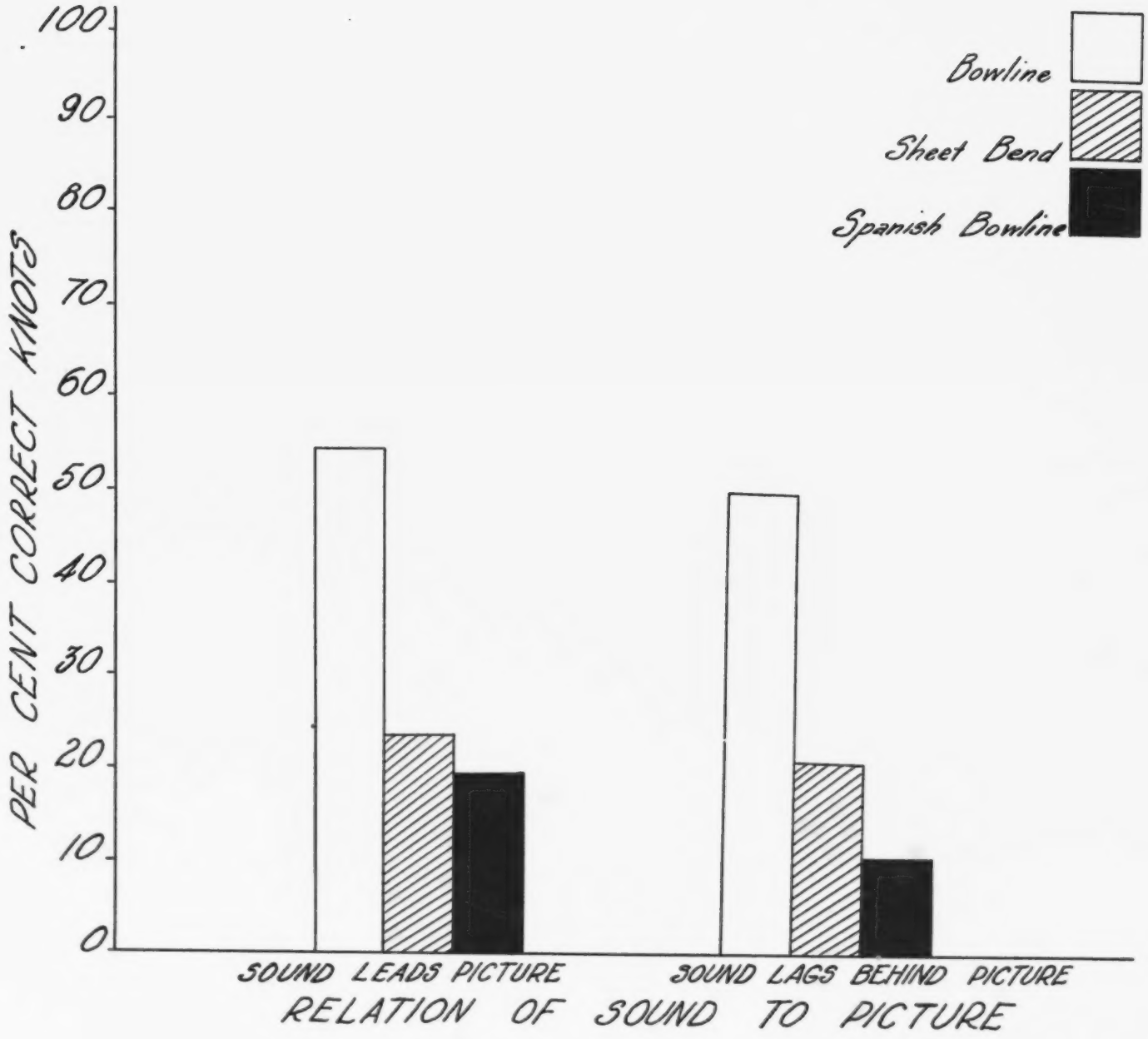


FIGURE 4. Knot tying performance (c) Phase relationship section of study

less confused by extraneous factors. In fact, it was the inclusion of several levels of difficulty which brought to the fore the differential effects of commentary variations in the films. The Spanish bowline provided the only discriminant in the phase-relations section of the experiment.

Variables related to knot-tying performance. In order to determine whether the experimental population was homogeneous within and among the various groups exposed to different films, information was secured from the Navy on the performance of most of the subjects on two Naval tests: the General Classification Test, and the Mechanical Aptitude Test. Both tests have been standardized by the Navy, and while it was expected that the populations tested would be comparable from group to group, it was also hoped that they would be representative of a general Naval population. The first expectation was realized, while the second was not. The means for the test populations were higher, and their variability more restricted than the standard for Navy populations in general. This implies that there was some selective factor operating in the intake of trainees during the period when the experiment was being conducted. Tables 11 and 12 give analyses of the groups for both tests, and it can be seen that the mean scores and the variabilities of the groups are comparable.

It was also possible to secure a measure of relationship between the two test scores, and knot-tying performance. A low significant positive correlation[1] was found between the performance on the Mechanical Aptitude test and knot-tying success, and between scores on the Navy G. C. T. and knot-tying success.

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[1] Bi-serial r, MA test scores versus knot-tying success = .30

Bi-serial r, GCT scores versus knot-tying success = .14

CONCLUSIONS

Before any conclusions about sound track variables are stated, some of the limitations imposed by the nature of this study should be reviewed. It was definitely an exploratory experiment, attempting to define and isolate variables whose nature is not fully known, and for which the defining criteria are mostly of an a priori nature. It is entirely possible that the definitions for levels of verbalization which were imposed upon the knot-tying task might not be applicable in some other context, whether it be teaching a skill or conceptual learning. The nature of the task itself, then, places severe restrictions upon what may be generalized from the results.

The presentation of the task in the films was very brief. When this is brought to mind, it may suggest that the differences actually found might have been greater had there been a longer time to present the material, or that the weakness of high verbalization was not the excessive description of detail, but the fact that its speed of presentation was too rapid.

The test situation was a military one, with the population accustomed to a certain amount of authoritarianism. This may have had considerable bearing on the personal reference section of the experiment.

While it is the hope of experimenters that test populations be typical of larger groups of individuals, it seems best to limit generalizations to the military population which was used.

The following conclusions, therefore, seem justified:

1. In teaching knot-tying tasks by means of instructional sound films, verbal descriptions of acts and relationships assisted the learners, but a very detailed description given within a short time interval interfered with, and actually reduced learning.

2. With a military population directive statements in the film commentary which used the imperative

mood, or the 2nd person active, were more effective in promoting learning than the 3rd person passive type of statements.

3. The temporal relation between the aural and visual elements in sound films demonstrating knot-tying had some bearing on the effectiveness of the films, in that a "leading" commentary seemed to promote more learning than a "lagging" commentary. It is possible that the level of difficulty and complexity of the task are closely related to this phase variable. Further research is needed to establish the procedures for ascertaining the optimum timing of picture and commentary in sound films.

RECOMMENDATIONS

The recommendations which may be offered are tempered by the knowledge that there is no strong body of evidence to back them up for all situations, yet it seemsappropriate to attempt to state some general principles without being extreme in advocating sweeping reforms.

Writers, directors and producers of instructional sound films might consider the following points:

1. Some particular level of verbalization is optimal and care should be taken not to over-load the sound track with too much detail and not to present the information too rapidly, nor, on the other hand should verbal descriptions of crucial visual relationships be omitted.

2. For military trainees accustomed to direct orders, strong directive statements may be more desireable for promoting learning than the passive statements which are often used in film commentaries.

3. Where the learner must be alerted to a relationship or detail to be presented on the screen, some advance direction in terms of seconds of commentary "lead" is desirable.

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Captain F. J. Grandfield, USN, Commanding Officer, Recruit Training Command, Great Lakes Naval Training Center, Great Lakes, Illinois, granted permission for the testing at the Center. Lt (jg) J. M. Bauer, USN, Scheduling Officer of the RTC was exceptionally helpful, and without his genuine interest and cooperation, the work of selecting and testing the 1787 Naval trainees would have been impossible. Lt. J. C. Kolisek, USN, provided the information on Navy test performances of the subjects. The instructors in the Seamanship Division, RTC, under Chief Warrant Officer E. L. Rowe, USN, expecially Chief Boatswain's Mate P. C. Asted, USN, gave assistance in projecting the experimental films. The commanders of Recruit Training Regiments provided the physical facilities for conducting the experiment, and Lt M. C. Rooksberry, USN, provided a temporary headquarters for the experimenters.

The author's wife, Rena Zuckerman carefully performed the laborious task of tabulating the raw data for the experiment, and provided the graphic illustrations for this report.

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Appendix A. Commentary Scripts

Script A.

Films No. II-III

Low level commentary, imperative mood, recorded with sound "leading" (Film II), and sound "lagging" (Film III).

"To tie a Bowline, pull out about three feet of line, and hold the line.
Form a small loop.
Pass the end of the line through this loop.
Pass this same end around the long end.
Then pass it through the small loop again, and place it alongside its own longer end.
Hold these two parts, and pull the long part until the knot is tight."

"The Sheet Bend is used to join two lines.
Cross the lines and hold them.
Loop the long part around its own end.
Grasp the short end of the line which is not looped.
Bring it down and through the loop, and place it alongside its own long part.
Take the long part of the other line and pull the loops tight."

"To tie the Spanish Bowline, hold the line.
Form a small loop.
Bring a large loop around the small loop.
Pin the crossover with the thumb.
Form another small loop.
Grasp the large loop and bring it up close to the two small loops.
Put one of the large loops through the small loop near it.
Grasp these two loops and the ends of the line and pull tight."

Script B.

Film No. IV

Medium level commentary, imperative mood.

"To tie a Bowline, pull out about three feet of line to the right, and hold the line.
Form a small loop above the line, by laying the right end in front of the left.
Pass the right end of the line through this loop from the rear.
Pass this same end around the long end from the rear.
Then pass it through the small loop again, from the front, and place it alongside its own longer end. Hold these two parts, and pull the long part until the knot is tight."

"The Sheet Bend is used to join two lines.
Cross the lines, with the left hand one toward you, and hold them.
Loop the long part on the right around the rear of its own end, the upper left end.
Grasp the short end of the line which is not looped.
This is the upper right end.
Bring it down and through the loop from the front, and place it alongside its own long part.
Take the long part of the right hand line and pull the loops tight."

"To tie the Spanish Bowline, hold the line.
Form a small loop above the line by laying the right end in front of the left.
Bring the right end in a large loop around the small loop from right to left.
Pin the crossover with the thumb.
Form another small loop to the right of the first one, laying the right end to the rear.
Grasp the lower end of the large loop and bring it up close behind the small loops.
Put the larger right hand loop through the small right hand loop from the front.
Put the larger left hand loop through the small left hand loop from the front.
Grasp these two loops and the ends of the line and pull tight."

Script C.

Film No. V.

High level commentary, imperative mood.

"To tie a Bowline, pull out about three feet of line to the right, and hold the line with the left hand.
With the right hand, form a small loop above the line by laying the right end in front of the left. The crossover is held with the left thumb.
Pass the right end of the line through this loop from the rear, forming a larger loop below.
Pass this same end around the long end from the rear.
Then pass it through the small loop again, from the front, and place it alongside its own longer end. Hold these two parts with the right hand, and pull the long part with the left until the knot is tight."

"The Sheet Bend is used to join two lines.
Cross the lines, about a foot from the ends, with the left hand one toward you,
and hold them at the crossover with the left hand.
With the right hand, loop the long part on the right around the rear of its own end, the upper left end, then forward so that it crosses between the two short ends, forming a small loop.
Grasp the short end of the line which is not looped. This is the upper right end.
Bring it down and through the loop from the front, and place it alongside its own long part. The parallel parts are held with the left hand.
With the right hand, take the long part of the right hand line, and pull the loops tight."

"To tie the Spanish Bowline, hold the line with the left hand about four inches from the left end.
With the right hand, form a small loop above the line by laying the right end in front of the left.

Bring the right end in a large loop around the small loop from right to left, leaving a one foot loop below.
Pin the crossover with the left thumb.
With the right hand, form another small loop, to the right of the first one, laying the right end to the rear.
With the right hand, grasp the lower end of the large loop and bring it up close behind the small loops, forming two medium sized loops.
The crossover is held with the left hand.
Put the larger right hand loop through the small right hand loop from the front.
Put the larger left hand loop through the small left hand loop from the front.
Grasp these two larger loops with the right hand, and the ends of theline in the left, and pull tight."

Script D.

Film No. VI

Medium lovel commentary, first person.

"I tie a Bowline by pulling out about three feet of line to the right and holding the line.
I form a small loop above the line, by laying the right end in front of the left.
I pass the right end of the line through this loop from the rear.
I pass this same end around the long end from the rear.
Then I pass it through the small loop again, from the front, and place it alongside its own longer end. I hold these two parts, and pull the long part until the knot is tight."

"I use the Sheet Bend to join two lines.
I cross the lines, with the left hand one toward me, and hold them.
I loop the long part on my right around the rear of its own end, the upper left end.
I grasp the short end of the line which is not looped. This is the upper right end.
I bring it down and through the loop from the front, and place it alongside its own long part.
I take the long part of the right hand line and pull the loops tight."

"I tie the Spanish Bowline by holding the line.
I form a small loop above the line by laying the right end in front of the left.
I bring the right end in a large loop around the small loop from my right to my left.
I pin the crossover with my left thumb.
I form another small loop to the right of the first one, laying the right end to the rear.
I grasp the lower end of the large loop and bring it up close behind the small loops.
I put the larger right hand loop through the small right hand loop from the front.
I put the larger left hand loop through the small left hand loop from the front.
I grasp these two loops and the ends of the line and pull tight."

Script E.

Film No. VII

Medium level commentary, second person.

"You tie a Bowline by pulling out about three feet of line to your right, and holding the line.
You form a small loop above the line, by laying the right end in front of the left.
You pass the right end of the line through this loop from the rear.
You pass this same end around the long end from the rear.
Then you pass it through the small loop again, from the front, and place it alongside its own longer end. You hold these two parts and pull the long part until the knot is tight."

"You use the Sheet Bend to join two lines.
You cross the lines, with the left hand one toward you,
and hold them.
You loop the long part on your right around the rear of its own end, the upper left end.
You grasp the short end of the line which is not looped, This is the upper right end.
You bring it down and through the loop from the front, and place it alongside its own long part.
You take the long part of the right hand line and pull the loops tight."

"You tie a Spanish Bowline by holding the line.
You form a small loop above the line by laying the right end in front of the left.
You bring the right end in a large loop around the small loop from your right to your left.
You pin the crossover with your left thumb.
You form another small loop to the right of the first one, laying the right end to the rear.
You grasp the lower end of the large loop and bring it up close behind the small loops.
You put the larger right hand loop through the small right hand loop from the front.
You put the larger left hand loop through the small left hand loop from the front.
You grasp these two loops and the ends of the line and pull tight."

Script F.

Film No. VIII.

Medium level commentary, third person passive.

"To tie a Bowline, the line is pulled out
about three feet to the right, and held.
A small loop is formed above the line, by
laying the right end in front of the left.
The right end of the line is passed through
this loop from the rear.
This same end is passed around the long end
from the rear.
Then it is passed through the small loop again,
from the front, and is placed alongside its
own longer end. The two parts are held,
and the long part is pulled until the knot
is tight."

"The Sheet Bend is used to join two lines.
The lines are crossed, with the left hand
one forward, and they are held.
The long part on the right is looped around
the rear of its own end, the upper left end.
The short end of the line which is not looped
is grasped. This is the upper right end.
It is brought down and through the loop from
the front, and is placed alongside its own
long part.
The long part of the right hand line is taken
and the loops are pulled tight."

"To tie the Spanish Bowline, the line is held.
A small loop is formed above the line by lay-
ing the right end in front of the left.
The right end is brought in a larger loop
around the small loop from left to right.
The crossover is pinned with the left thumb.
Another small loop is formed to the right of
the first one, the right end being laid to
the rear.
The lower end of the large loop is grasped,
and it is brought up close behind the small
loops.
The larger right hand loop is put through the
small right hand loop from the front.

The larger left hand loop is put through the small left hand loop from the front.
These two loops and the ends of the line are grasped, and the line is pulled tight."

Appendix B. Instructions to Subjects

"Instructions to Subjects"[1]

"Take every other seat; do not sit on the seats containing test materials.

"Remove your coats or jackets; place your 'Bluejacket's Manuals' under the seat.

"You men are here to take part in a special study of recruit training being made by the Office of Naval Research. You are to be tested today, so pay close attention to everything I tell you, and follow my instructions exactly. On the seat next to each of you, there is a group of envelopes. Take the top envelope in your lap, holding it flat, so that the line inside does not spill out. There should be a white slip of paper on the upper left corner of the envelope.

"Proctors, pass pencils to the men.

"Now print, on the slip of paper, in the space provided, your name, last name first, your first name, and then your middle initial, if any. Below your name, print your service number. Below the service number, print your company number and after it the capital letter "A".[2] As soon as you have finished the first envelope, print the same information on the others, keeping them in the proper order. Be sure to print clearly.

"You are about to see some films which will show you how to tie knots. After the films, you will be asked to tie the knots. Do not touch the test materials until I give the signal. When I give the signal to stop, stop your work. We cannot answer any questions about the films, or while you are tying knots, so tie them the best way you can. Do NOT look at your neighbors; tie your own lines. The films are very short, so watch them closely. Do you understand the directions?

"Be sure to wait until I give the signal before you touch the envelopes. All right: lights, first picture.

(MOTION PICTURE ON THE BOWLINE)

"Pick up the top envelope, take out the line, and tie the knot.

(TIME ALLOWANCE OF 1½ MINUTES FOR TYING)

"Whether or not you have finished tying the knot, put the knot or the line in the envelope. Pass the envelopes to the end of the row.

(REPEAT FOR TWO MORE KNOTS)"

(1) When the subjects were admitted to the testing rooms they were divided into two groups, designated "A" and "B". The instructions in the two rooms were identical, with the exception of the identification of the group.

(2) or "B", depending on the room.

Appendix C. Statistical Tables 4-12

TABLE 4

KNOT-TYING PERFORMANCE: GROUPED-DATA ANALYSIS: PROPORTIONS OF SUBJECTS TYING EACH KNOT, AND STANDARD ERRORS OF PROPORTIONS

Film Version*	N	Bowline p	Bowline σp	Sheet bend p	Sheet bend σp	Spanish bowline p	Spanish bowline σp
I	164	.43	.04	.26	.03	.13	.03
II	339	.54	.03	.24	.02	.20	.02
III	171	.50	.04	.21	.03	.11	.02
IVa**	170	.64	.04	.30	.04	.24	.03
IVb**	167	.70	.04	.32	.04	.21	.03
V	168	.54	.04	.24	.03	.20	.03
VI	167	.64	.04	.27	.03	.23	.03
VII	223	.66	.03	.34	.03	.22	.03
VIII	218	.65	.03	.23	.03	.17	.03

* See Table 3, page 16, which describes each film version.

** Although the film versions indicated as IVa and IVb are identical, separate analysis has been carried on throughout because the data for the two films were gathered during different sections of the study, and erroneous scoring of one knot was suspected during one portion of the study. See Table 7, and the discussion on page 26, under Results, and on page 61, under Statistical Treatment.

TABLE 5

KNOT-TYING PERFORMANCE: GROUPED-DATA ANALYSIS:
MEANS AND STANDARD DEVIATIONS OF DISTRIBUTIONS
AND STANDARD ERRORS OF MEANS

Film Version	N	M*	σ	σ_m
I	164	.82	.08	.006
II	339	.98	.09	.005
III	171	.81	.08	.006
IVa**	170	1.18	.10	.007
IVb**	167	1.23	.08	.007
V	168	.98	.08	.007
VI	167	1.14	.08	.007
VII	223	1.21	.08	.006
VIII	218	1.04	.08	.006

* Mean scores were derived by assigning scores of "one" for success and "zero" for failure to each subject for each knot; the highest possible score for an individual was three.

** See Note (**) to Table 4.

TABLE 6

KNOT-TYING PERFORMANCE: GROUPED-DATA ANALYSIS:
DIFFERENCES IN MEAN SCORES AMONG ALL FILM VERSIONS

Section of Study	Film Version	Differences among mean scores#			
		I	II	IVa	V
Level of Verbalization	I		.15	.35***	.16
	II			.20**	.006
	IVa/				(-).19*
	V				
		IVb	VI	VII	VIII
Personal Reference	IVb/		(-).09	(-).01	(-).19*
	VI			.08	(-).10
	VII				(-).17*
	VIII				
			II	III	
Phase Relationship	II			(-).16*	
	III				

Differences marked (*) are significant at the 5% level of confidence, those marked (**) at the 1% level, and those marked (***) at the .1% level. Positive differences favor the version numbered at the top of the columns.

/ See note (**) Table 4.

TABLE 7

KNOT-TYING PERFORMANCE: GROUPED-DATA ANALYSIS: DIFFERENCES AMONG PROPORTIONS OF KNOTS TIED FOR ALL FILM VERSIONS: DIFFERENCES AMONG PROPORTIONS FOR EACH KNOT TIED.#

Section of Study	Film Version	Bowline				Sheet bend				Spanish Bowline			
		I	II	IVa	V	I	II	IVa	V	I	II	IVa	V
Level of Verbalization	I		.11*	.20***	.11*		.02	.04	.02		.07*	.11**	.07
	II			.09*	(-).00			.06	.01			.05	.00
	IVa				(-).09				(-).06				(-).04
	V												
		IVb	VI	VII	VIII	IVb	VI	VII	VIII	IVb	VI	VII	VIII
Personal Reference	IVb		(-).06	(-).05	(-).05		(-).05	.02	(-).09*		.02	.01	(-).04
	VI			.01	.01			.07	(-).04			(-).01	(-).06
	VII				(-).00				(-).12**				(-).05
	VIII												
			II	III			II	III			II	III	
Phase Relationship	II			(-).05				(-).03				(-).09**	
	III												

Differences marked (*) are significant at the 5% level of confidence, those marked (**) at the 1% level, and those marked (***) at the .1% level. Positive differences favor the film version numbered at the top of the columns.

TABLE 8

CHI SQUARE TESTS OF KNOT-TYING PERFORMANCES:
GROUPED-DATA ANALYSIS

Section of Study	Chi Square	d/f	p
Level of verbalization (Films I, II, IVa, V)	13.81	6	.02
Personal reference* (with bowline) (Films IVb, VI, VII, VIII)	8.80	6	.20
Personal reference* (without bowline (Films IVb, VI, VII, VIII)	8.26	3	.03
Personal reference* (bowline only) (Films IVb, VI, VII, VIII)	.54	3	.95
Phase relationship (Films II, III)	6.37	2	.03

* Because of some erroneous scoring during part of the personal reference section of the study, the analysis for that section is given several ways, with and without the bowline, and for the bowline alone. It seems clear that there are significant differences among the film versions when the bowline scores are not considered. See note to Table 4.

TABLE 9

KNOT-TYING PERFORMANCE: RANDOM-HALF ANALYSIS OF DATA: COMPARISON WITH GROUPED-DATA RESULTS

Film versions and knots compared	Differences in proportions				Standard errors of differences				Probability values: Random-half				Probability values: Grouped-data
Level of Verbalization	No. of comparison* 1st	2nd	3rd	4th	No. of comparison 1st	2nd	3rd	4th	No. of comparison 1st	2nd	3rd	4th	
I versus II**													
Bowline	.21	.10	.02		.10	.13	.13		.03	.46	.88		.02
Sheet bend	-.03	-.01	.11		.08	.12	.12		.70	.90	.36		.59
Spanish Bowline	.15	.08	.09		.07	.11	.10		.03	.45	.37		.05
I versus IVa													
Bowline	.21	.33	.17		.09	.13	.13		.02	.01	.19		.00
Sheet bend	.06	.04	.19		.09	.12	.12		.48	.73	.10		.44
Spanish bowline	.14	.21	.11		.07	.10	.10		.06	.03	.30		.01
I versus V													
Bowline	.17	.37	.21		.10	.13	.13		.07	.01	.10		.05
Sheet bend	.10	-.04	-.04		.08	.11	.12		.23	.72	.76		.70
Spanish bowline	.11	.17	.14		.07	.10	.11		.10	.09	.18		.09
II versus IVa													
Bowline	.12	.00	.15		.09	.13	.13		.20	.99	.24		.04
Sheet bend	.07	.09	.09		.08	.12	.12		.37	.44	.44		.15
Spanish bowline	.06	-.01	.02		.08	.10	.11		.46	.90	.87		.23
II versus V													
Bowline	.15	-.04	.12		.09	.14	.13		.09	.77	.37		.98
Sheet bend	-.01	.13	-.02		.08	.12	.12		.91	.27	.85		.99
Spanish bowline	.02	-.03	.06		.07	.10	.11		.76	.76	.57		.96

(Table continued on next page)

TABLE 9 (continued)

Film versions and knots compared	Differences in proportions No. of comparison 1st	2nd	3rd	4th	Standard errors of differences No. of comparison 1st	2nd	3rd	4th	Probability values Random-half No. of comparison 1st	2nd	3rd	4th	Grouped-data
IVa versus V													
Bowline	.00	-.04	-.04		.09	.13	.13		--	.76	.78		.08
Sheet bend	-.10	.00	-.08		.08	.12	.12		.24	--	.47		.25
Spanish bowline	.01	-.02	-.03		.08	.10	.11		.99	.82	.74		.32
Personal reference													
IVb versus VI													
Bowline	-.06	-.22	.05		.09	.13	.13		.50	.09	.70		.24
Sheet bend	-.06	.14	-.19		.09	.12	.12		.45	.27	.10		.34
Spanish bowline	-.05	.06	.03		.08	.11	.11		.56	.57	.78		.69
IVb versus VII													
Bowline	-.05	-.07	.10		.09	.13	.13		.60	.57	.44		.34
Sheet bend	.13	-.08	-.01		.09	.12	.12		.13	.50	.92		.61
Spanish bowline	.11	.00	.01		.08	.11	.11		.14	.97	.96		.81
IVb versus VIII													
Bowline	-.01	-.12	.01		.09	.13	.13		.88	.34	.92		.30
Sheet bend	-.23	-.10	-.02		.08	.12	.12		.01	.42	.90		.04
Spanish bowline	.02	-.06	.13		.07	.11	.11		.84	.58	.23		.27
VI versus VII													
Bowline	.17	.01	-.12		.09	.12	.13		.06	.91	.34		.77
Sheet Bend	-.01	.20	.11		.09	.12	.12		.95	.11	.32		.13
Spanish Bowline	.05	.16	.00		.08	.11	.11		.52	.15	.99		.86
VI versus VIII													
Bowline	-.06	.23	.05		.09	.13	.13		.51	.07	.70		.83
Sheet bend	-.03	-.15	-.16		.08	.12	.12		.69	.21	.18		.32
Spanish bowline	.01	-.07	-.06		.08	.11	.11		.85	.54	.57		.13
VII versus VIII***													
Bowline	.06	.09	-.23	.04	.09	.09	.13	.13	.51	.31	.07	.79	.94
Sheet bend	-.15	-.06	-.03	-.04	.08	.09	.12	.12	.08	.48	.82	.00	.01
Spanish bowline	-.02	-.10	-.07	-.10	.07	.08	.11	.11	.84	.20	.55	.36	.15

TABLE 9 (Continued)

Film versions and knots compared	Differences in Proportions No. of comparison 1st	2nd	3rd	4th	Standard errors of differences No. of comparison 1st	2nd	3rd	4th	Probability values Random-half No. of comparison 1st	2nd	3rd	4th	Grouped-data
Phase relationship													
II versus III*													
Bowline	-.15	-.08	-.05		.09	.09	.09		.10	.41	.61		.33
Sheet bend	-.09	-.02	-.05		.08	.08	.08		.28	.78	.54		.45
Spanish bowline	-.11	-.02	-.15		.07	.07	.07		.12	.77	.02		.01

* The first of the three comparisons is direct, while the other two are made through intervining film versions. See the discussion of the experimental design for a description of the procedure.

** Positive differences favor the higher numbered film version.

*** For version VII versus VIII the first <u>two</u> comparisons are direct, the other two indirect.

TABLE 10

KNOT-TYING PERFORMANCE WITH AND WITHOUT FILM INSTRUCTION *

Type of Instruction	N	Bowline		Sheet bend		Spanish Bowline	
		p	σ_p	p	σ_p	p	σ_p
None	112	.07	.02	.03	.02	.00	---
Film Instruction	114	.52	.05	.31	.04	.21	.04

* Subjects in this control experiment were not included in the rest of the study, but were drawn from the same general trainee population at the time the main experiment was carried out. The experimental procedure was the same as for the main study.

TABLE 11

Part I: SCORES ON NAVY GENERAL CLASSIFICATION TEST*

Film Version	N	Mean	σ	σ_m
I	153	55.4	8.18	.66
II	324	55.2	8.41	.47
III	157	54.4	8.92	.71
IVa	150	55.0	7.37	.60
IVb	167	53.6	8.74	.68
V	161	54.4	8.52	.67
VI	163	55.1	8.64	.68
VII	208	54.6	8.22	.57
VIII	206	53.8	8.46	.59

Part II: ANALYSIS OF VARIANCE: NAVY GENERAL CLASSIFICATION TEST

Source of Variation	d/f	Sum of Squares	Mean Square	F ratio**
Total	1688	119724.9	70.93	
Between Groups	8	570.8	71.35	
Within Groups	1680	119154.1	70.93	1.01

* Navy standard score for this test is M = 50, σ = 10.

** F.05 = 1.94

TABLE 12

Part I: SCORES ON NAVY MECHANICAL APTITUDE TEST*

Film Version	N	Mean	σ	σ_m
I	153	51.6	8.50	.69
II	324	51.2	8.59	.48
III	157	51.0	8.23	.66
IVa	150	53.0	7.83	.64
IVb	167	50.8	7.49	.58
V	161	51.4	8.02	.63
VI	163	52.0	8.53	.67
VII	208	51.4	8.00	.56
VIII	206	50.6	8.04	.56

Part II: ANALYSIS OF VARIANCE: NAVY MECHANICAL APTITUDE TEST

Source of Variation	d/f	Sum of Squares	Mean Square	F ratio**
Total	1688	113,700.4	67.36	
Between groups	8	689.4	86.18	
Within groups	1680	113,011	67.27	1.28

* Navy standard score for this test is $M = 50, \sigma = 10$.

** $F.05 = 1.95$

Appendix D. Statistical Procedures

Basic statistical assumptions. In order to make explicit the various hypotheses and assumptions underlying the statistical techniques which were used in the analysis of the data of this study, the design of the experiment is reviewed below.

It will be recalled from the discussion of the experimental design, that the experiment was performed in three sections, each of which was considered independent of the others. All possible independent comparisons for each pair of points within a continuum were to be made. No comparisons were made of interaction among dimensions.

The test unit for each of the comparisons was a group of about 120 Naval trainees, divided randomly into two groups of equal size, each of which was shown a different film. Since this administration of testing left the portion of the experiment on phase relations with only one comparison, based on a relatively low N, two additional replications of that section were made, so the sample sizes were comparable with those for the other sections of the study. In addition, since the personal reference commentaries differed from one another by only the interchange or addition of a handful of personal pronouns, it was thought advisable to make an additional replication for the comparison which yielded the largest individual difference in proportions. This turned out to be the comparison of 2nd with 3rd person, that is, films VII and VIII. Examination of Table 4 which contains the number of subjects for each version will illustrate this point.

The assumption as to the validity of the performance task as a measurement criterion was the usual one with respect to face validity of performance, as a measure of learning from films demonstrating the task. It was furthermore assumed that random sampling would hold to chance levels any differential effects due to differences in knot-tying ability or variables relevant to this ability in the population.

The sampling assumption was met in practice by several cumulative procedures. First, though the sections of the experiment were given an arbitrary

order of administration, the comparisons within each section were ordered by means of a table of random numbers. Then, all trainees entering the Naval Center during the period of the testing were used in the experiment. Also, in the random-half method of analysis, any two films were compared within the confines of random halves of a pair of recruit companies which had entered the Center at the same time, and had worked together. This randomization was achieved by splitting the companies into two groups by choosing men alternately from a marching column arranged according to height.

In the grouped-data method of analysis it was assumed that the entire population of subjects was homogeneous with respect to knot-tying ability and relevant variables, thus data secured for each film version could be added together to provide large samples, to reduce the standard errors of the measures used for the analysis. This assumption has been met, as will be shown later.

Statistical Treatment

Grouped-data method. The information acquired for each film version within each section of the experiment was aggregated into a single value in terms of the dichotomous scoring used. There were two important special cases. Film version II was used in two sections of the study (see Table 2 for a description of the film criteria). Complete data for this version were added together. Film version IV was also used in two sections of the study. However, it was found that one group of scorers was assigning erroneous values to bowline scores during the personal-reference section of the experiment. Therefore, the data for this section were separated from the data gathered during the level of verbalization section for the same film, and the film was carried through the analysis as "Film IVa" and "Film IVb". (See Table 4, Appendix C.) In addition to this precaution it was found advisable to apply chi square tests to the personal-reference section of the study, with and without the bowline scores included. The tests showed that with the bowline data included, there were no significant differences; the differences without the bowline were statistically significant.

As a general procedure, the chi square test was applied to each of the three sections of the experiment,

before the individual differences were compared, to test whether capitalization of chance differences might occur (McNemar, pp 209-210, 11). In testing the individual differences, the formula for the standard error of the differences between proportions was:

$$\sigma Dp = \sqrt{\frac{p_1 q_1}{N_1} + \frac{p_2 q_2}{N_2}}$$

where p_1 and p_2 (designed to approximate population values) were obtained from the grouped data for the film versions being compared, a procedure which is justifiable, according to McNemar (11, page 76).

In order to obtain overall scores for each film version, and to use all information from all three knots, a total score was calculated for each subject, with a score of "one" assigned for success, and "zero" for anything else. The mean scores secured were analyzed by the CR technique. In this case the standard error of the differences between means used the usual approximation (8 pp 56-57) for population variance involving N-1 in the denominator, which was as follows:

$$\sigma Dm = \sqrt{\frac{N_1 + N_2}{N_1 + N_2 - 2}} \cdot \sqrt{\frac{s_1^2}{N_2} + \frac{s_2^2}{N_1}}$$

where s_1 and s_2 were the variances of the sample distributions involved.

Random-half control method. The information from each administration of test films was arranged separately in order to test each of the possible differences within each section of the study. The experimental design provided, for any pair of points on the level of verbalization dimension and the personal reference dimension, one direct and two indirect comparisons. In addition, in the personal reference section there was an added direct comparison of films VII and VIII, while in the phase relationship section there were three direct comparisons only. The data for this method are presented in Table 9 Appendix C.

The CR technique was used to evaluate the significance of the differences. Where the comparisons were direct, the standard error formula used was:

$$\sigma Dp = \sqrt{\frac{p_1 q_1}{N_1} + \frac{p_2 q_2}{N_2}}$$

where p_1 and p_2 were values from the grouped-data for the two film versions involved, since these were considered to be best estimates of population values (11, page 76). When the indirect comparisons were made, the standard errors used were:

$$\sigma Dp = \sqrt{\frac{p_1 q_1}{N_1} + \frac{p_2 q_2}{N_2} + \frac{p_3 q_3}{N_3} + \frac{p_4 q_4}{N_4}}$$

(these were actually standard errors of differences between differences) where the p values were obtained in the same manner as outlined above. These tests led to independent probability figures for each comparison. In order to compare these with the probability figures secured in the grouped-data analysis that figure is also listed for each paired comparison in Table 9. It will be noted that some differences in signs were found in the random-half analysis. These differences prevented the application of a transformation of the independent probabilities to an overall figure, suggested by Lindquist (8,pp 46-47). However, a general idea of the comparison of the two methods can be obtained by examining the several values for the random-half control analysis and comparing them by inspection with the grouped-data figure.

Population tests on relevant variables. In order to justify the assumption of homogeneity of variance, with respect to knot-tying ability and other relevant variables, which was made for the grouped-data analysis, and to obtain some measure of the degree of relationship which might exist between Navy classification test scores and knot-tying, analyses of variance were carried out on the General Classification Test and the Mechanical Aptitude Test scores available for 1689 subjects of the 1787 used in the experiment. Bi-serial correlation coefficients were used as the measure of relationship between the two kinds of test scores and knot-tying. These were evaluated for significance by using the standard error formula given by McNemar (11): $\sigma V_b = \frac{\sqrt{p_1 p_2}}{z\sqrt{N}}$

In order to further another project of the Instructional Film Research Program regarding the characteristics of film learners, a verbal intelligence test (the Verbal-Meaning section of the Science Research Associates Primary Mental Abilities Test, developed by L. L. and T. G. Thurstone) was administered during the level of verbalization section of the study. The results will be published in another report of the Program. However, a preliminary analysis of variance showed that the population used in the level of verbalization section of the experiment, was homogeneous with respect to performance on this test.